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ACTIVITY AS A FUNCTION OF FOOD DEPRIVATION AND EXTERNAL STIMULATION

by

Terrance Allan Collins

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "Activity as a Function of Food Deprivation and External Stimulation", submitted by Terrance Allan Collins in partial fulfilment of the requirements for the degree of Master of Arts.

Abstract

Seventy-two male hooded rats were used to explore the relationship between food deprivation, change in external stimulation, and the resulting level of activity. Activity was measured using photocells, intersecting stabilimeters and also micro-switches mounted beneath the stabilimeters. The animals were split equally into three groups; one group subjected to an increase in external stimulation, another to a decrease in external stimulation, and the third group became the control group for this factor, with no change in stimulation. Each of these groups was then divided in half and placed on either a one hour or a twenty-three hour deprivation schedule.

No evidence was found to support the hypothesis that increased food deprivation alone results in an increased locomotor activity level. Nor was evidence found to suggest that a change in external stimulation level resulted in an increase in locomotor activity.

An attempt was made to explain this as being the result of lack of sensitivity in the covariance analysis to compensate for initial differences in the deprivation groups.

Similarly, there was lack of evidence to support the same hypotheses for activity measured by the micro-switches. It was found, however, that the groups receiving a stimulus decrease did have a mean significantly higher than the other two stimulus groups. This was interpreted however, to be the result of anticipation of the stimulus decrease having positive reinforcing properties on non-locomotor behavior.

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I would like to extend my sincere appreciation to Dr. R. Walley who supervised this investigation and to the other members of my committee; Dr. W. A. S. Smith and Dr. W. Runquist for their helpful suggestions

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INTRODUCTION

1898 saw the introduction of the activity wheel into psychology. In an attempt to measure the variations in activity resulting from the influence of alcohol, barometric pressure, and diet, Stewart (1898) devised this now common instrument. The invention of this apparatus coincided with an increased interest in the question of instincts, simple reflexes, tropisms, drive and motivation. C. P. Richter, under the influence of the functionalists became interested in the question of what "drives" the animal about, i.e., what makes it active. His experiment (1922) using a tambour mounted stabilimeter to measure activity was one of the first studies to demonstrate a relationship between food deprivation and overt activity (as opposed to the more covert activity such as stomach contractions being explored at that time as such men as King, Connett, and Cannon). Citing evidence from Cannon's work, Richter argued that stomach contractions resulting from food deprivation produced a general state of restless, or random, activity in an animal. Thus drive for Richter had an energizing but not a directing effect on behavior. The direction which evolved from these random movements did so as a result of trial and error learning with positive reinforcement of those movements which decreased the drive.

Since then, many experiments have been conducted on the relationships between activity level and variables such as food, water, temperature, age, sexual deprivation, "need" for specific foods, and external stimulation, to list a few. Because the studies have been reviewed in detail by Hall (1961), the present discussion will focus only on those studies

having direct relevance to the present one. At the outset, it should be noted that results in this area are somewhat disparate, techniques inconsistent, and published replications non-existent.

A separation of the effects of food deprivation and water deprivation on activity level is difficult to achieve. To the author's knowledge, it has not yet been satisfactorily accomplished. A common observation in studies involving the use of food-deprived animals, is that water consumption by these animals is reduced considerably. Similarly, food consumption is reduced in water-deprived animals. Verplanck and Hayes (1953) have demonstrated this relationship experimentally. They found that Ss placed on twenty-one hours water deprivation, ate only 67% as much food as that eaten by non-water deprived subjects. Similarly, animals placed on a twenty-one hour food deprivation schedule drank only 40% as much water as non-food deprived animals. Comparing the effects of water deprivation with those of food deprivation on the amount of food ingested, they also found that animals with access to both food and water following a twenty-one hour water deprivation interval would consume the same quantity (by weight) of food as animals that had been deprived of food for the same period. The same relationship was found for the amount of water ingested in animals placed on a food deprivation schedule compared with those placed on a twenty-one hour water deprivation schedule.

Several studies have used animals placed only on water deprivation. Wald and Jackson (1944) and Finger and Reid (1952) have both demonstrated an increasing activity level with increasing deprivation states. Both

of these studies used rats and measured the effects using an activity wheel. In a portion of a study by Hall, Hanford and Low (1960), animals placed under a twenty-two hour water deprivation schedule showed a significantly greater activity level than satiated animals in a Dashiell maze. This difference was consistent over the five test days. Generally then, it would appear that activity does increase as a result of water deprivation.

Investigations of the relationship between food deprivation and activity provide the largest group of experiments. Richter's 1922 study, reported earlier, supported an hypothesis suggesting that a food deprivation state increases activity. Studies by Siegal and Steinberg (1949) and Teitlebaum (1957) also support this hypothesis. Siegal and Steinberg divided their animals into four groups and measured activity in a stabilimeter under 0, 12, 24, and 48 hours of food deprivation. They found that the level of activity increased with increasing levels of deprivation. Irwin (1932) found the same relationship in human infants whose activity was measured on a stabilimeter over a four hour period which separated two feeding times.

Similar results have been obtained using open field measures (Dashiell, 1925; Adlerstein and Fehrer, 1955; and Fehrer, 1956). Further supporting evidence for this relationship comes from Hall (1956), Finger (1951) and Hitchcock (1927), all of whom used the activity wheel to obtain their measures.

It will be noted that in the studies on the effects of food deprivation on activity, several types of measuring devices were used.

The type of apparatus used has proven to be of some importance in that different measuring devices apparently measure different kinds of activity. Reed (1947) for example, after reviewing the literature in 1947, points out that "...where comparable measures of activity are available from different devices, running drum and diffuse activity cage, the results are not the same." (Reed, 1947). Recent experimental evidence to support this statement is found in the studies of Treichler (1960) and Eayrs (1954). These men were antedated by a study by Hunt and Schlosberg (1939), who concluded from their studies that the stabilimeter measured a "general restlessness in the organism in contrast to the specific running behaviour as measured by the drum." (Hunt and Schlosberg, 1939). Strong (1957) measured activity under 0, 24, 48, and 72 hours food deprivation. In measuring their activity, he used two types of apparatus. The first was a "contact" stabilimeter which was designed so that several electrical contacts were soldered on to the bottom of an ordinary stabilimeter. The second was an ordinary microswitch stabilimeter. By design, the former apparatus was the more sensitive of the two, i.e., reacted to smaller movements. The animals were divided into two groups, one group using the stabilimeters mounted on microswitches while the other used the contact stabilimeter. These two groups were further sub-divided into four deprivation groups which were balanced for age, sex, and basal activity level. In reporting his results, Strong also used the results of Hall (1956), and Siegal (1949). Fig. 1 gives an indication of the comparative results using different measuring devices. With the animals using the contact stabilimeter, the results indicated that under food deprivation they were not

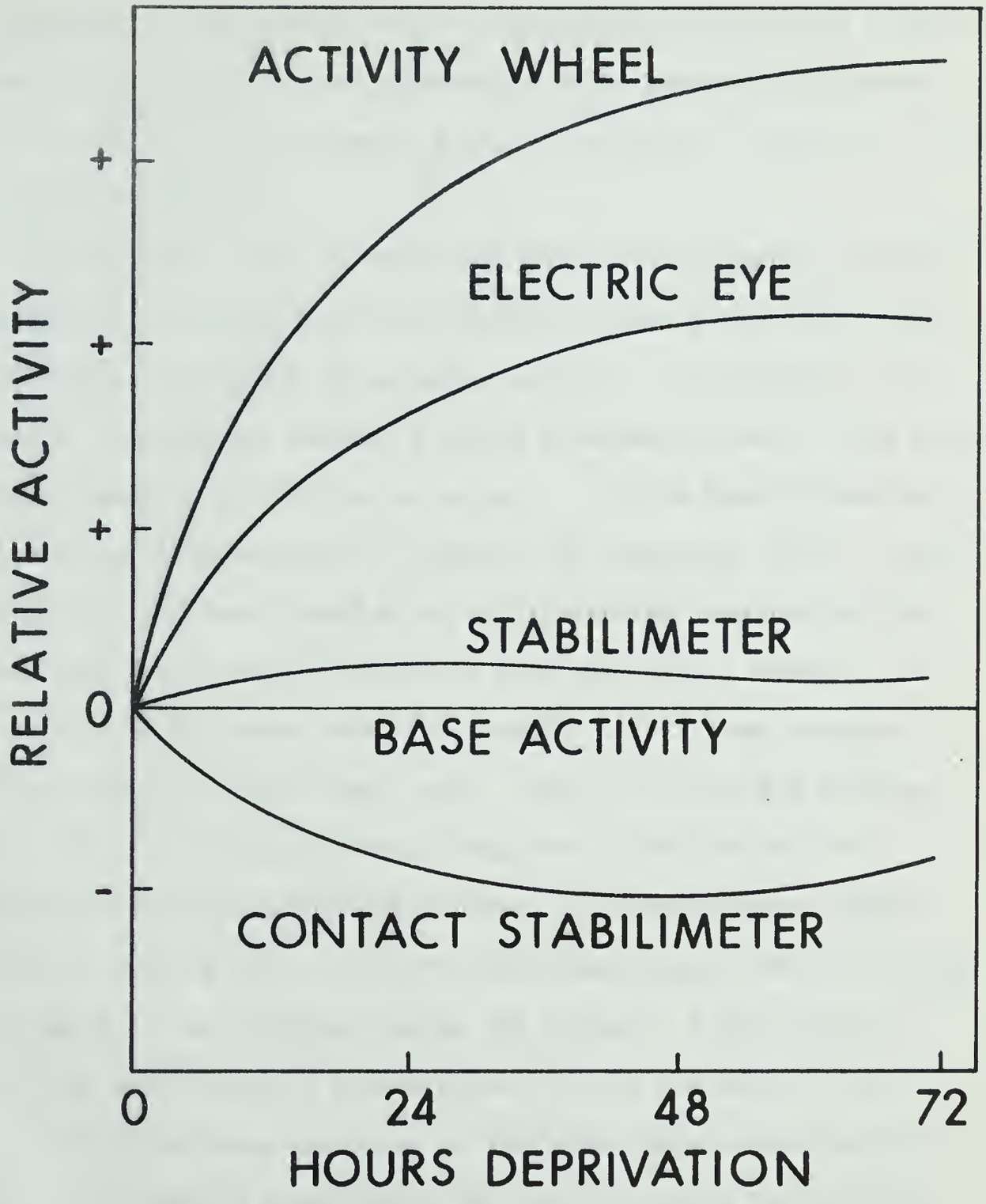

FIG 1

Activity as a function of hunger and apparatus (Strong, 1957)

only significantly less active than controls, but were also significantly less active than their own basal rate. With the microswitch group, there was no significant difference between deprived and non-deprived animals. His conclusion was that a food deprivation state produces an increase in activity of the gross locomotor kind, but produces a decrease in fine non-locomotor activity.

Most current theories which deal with the relationship between food deprivation and activity rate hypothesize that a food deprivation state increases the amount of locomotor activity. In contrast to this hypothesis, Campbell and Sheffield (1953) hypothesized that "there would be little change in activity in an animal in a drive state unless there was some external stimulation." (Campbell and Sheffield, 1953). Twelve mature albino rats were placed on an ad lib feeding schedule for four days and then subjected to a three day food deprivation schedule. At the same time on all seven days, the animals' activity was recorded for twenty minutes in their home cages. After the first ten minutes of this interval, an environmental change was introduced and the activity recorded for another ten minutes. The environmental change consisted of turning off a constantly operating exhaust fan and turning on the lights in the cabinets housing the animals. A base line of activity was established by recording activity on all days for the entire twenty-four hours exclusive of the twenty minute experimental period. A microswitch stabilimeter was used to measure the activity.

Comparing the activity rate during the experimental period with the basal rate, the results showed that an environmental change produced an increase in activity regardless of the length of deprivation period.

There was no change in activity over the basal rate during the first ten minutes of the experimental period as they predicted. The basal rate of activity also increased though only very slightly, during the last three days. Thus, both the total activity level and the activity level following the environmental changes were increased under a food deprivation state, but the environmental change when added, had a far greater effect. Statistically, the difference between total activity level and the level following the environmental change was highly significant. The authors interpreted this to mean that the effect of a drive state is to lower the threshhold for reaction to changes in external stimulation.

Hall (1956) points out that their conclusions are contradictory to their results, i.e., there was in fact an increase in total activity, small though it may be, during a deprivation condition. Thus, he reasons, it would seem more reasonable to conclude that an increased drive state would produce an increase in activity regardless of external stimulation conditions. Increasing or changing the level of external stimulation should enhance and add to the effect of the drive state.

In order to test this hypothesis, Hall took twelve mature albino male rats and recorded their activity in revolving drums. The drums also doubled as living quarters for the animals. All Ss were placed on the drum for a fourteen day adaptation period on an ad lib feeding schedule in a completely darkened room. Following adaptation, activity was recorded on days one through nine for one-half hour at the same time each day. The animals were housed in a darkened room, and the only

auditory stimulation resulted from movement of rats in the activity wheel (35 to 46 db). This was defined as the "normal" envirmonment. At the end of that half hour, a recorded buzz started, playing intermittently with the buzz on for two minutes, and off for 30 seconds, and a one hundred and fifty watt bulb started flashing. This condition provided the experimental change--in this case an increase in stimulation--which lasted for one-half hour during which activity was recorded again. At the end of the experimental period of day nine, half of the Ss were placed on a three day deprivation schedule and the activity was recorded on all three days for all animals as before. The results of the study support his hypothesis, i.e., activity increases under food deprivation and the effects of increasing external stimulation add to this effect by further increasing the activity level.

Several questions are left unanswered by both of these studies. In Campbell and Sheffield's study, the environmental change consisted of increasing the amount of light and decreasing the amount of sound. Thus the effects of increased stimulation or decreased stimulation on activity level were not explored. According to their predictions however, a "change" alone regardless of the direction of that change, should produce an increase in activity. Hall's study, however, is not comparable to the Campbell-Sheffield study. There was an appreciable difference in the ages of the animals used. The apparatus used to record the activity was also different. It is quite probable that the activity wheel produces its own source of stimulation thus being a possible cause of the increase in activity.

Even the factor of "stimulus change" is not comparable. In Hall's study the animals were subjected to a sequentially increasing-decreasing level of stimulation. Campbell-Sheffield on the other hand had a constant stimulus increase in one sense mudality but a constant stimulus decrease in another mudality. The experimental period in Hall's study was also much longer than that in the Campbell and Sheffield study.

The present experiment was designed to further explore the relationship between activity, stimulation and deprivation. The main questions asked were:

(a) does deprivation produce increased activity?

(b) does a change in stimulation produce increased activity?

(c) is there an interaction between deprivation and stimulation, i.e., do changes in activity with deprivation depend on an increase or decrease in stimulation?

In view of the experimental results to date, the following predictions were made for this study:

(a) a food deprivation state will produce an increase in overt locomotor activity; and

(b) a change in external stimulation will add to the increase in activity resulting from food deprivation.

Because of Strong's findings (1957) it was decided that two methods of recording the activity level would be employed. Thus micro-switches, activated by a pivoting stabilimeter, and photoelectric cells were employed. It was predicted that the photoelectric device would be more sensitive to locomotor activity and would therefore show more marked changes in activity with deprivation and stimulation than would the stabili-meter.

Subjects

Seventy-two male black-hooded rats of the Royal Victoria strain were used. All animals were 80 days old upon arrival in the laboratory. Immediately upon arrival, they were placed in their home cages under a "standard" environmental condition. Owing to time and space limitations, the Ss could only be ordered twenty-eight at a time (including substitutes). When that group of animals had been run a new lot was ordered. Any physically defective animals are immediately discarded and a substitute entered in its place.

Apparatus

The apparatus was kept in the same room as the colony. It consisted of three large boxes stacked on top of another which housed the stabilimeters; two stabilimeters per box. The box, 4'1½" by 2' by 1'10½", was constructed of 5/8" plywood on the top, bottom and sides, and 3/8" plywood on the back and front. The front side was hinged at the bottom and could be opened by undoing a hook fastener at the top and lowered to give access to the experimental units inside.

Each box was accoustically insulated with fiberglass. An audiometer test showed this insulation to be effective. All boxes were painted gray on the inside. Each was separately ventilated by a Rotron Whisper Fan capable of moving 400 cubic feet of air a minute. The two experimental units were separated visually by a sheet of white poster board hung from the ceiling.

The experimental apparatus per se consisted of two parts. The stabilimeter consisted of a square topless box, with sides 1'4" in

length and 6" deep. It was constructed of clear plastic and, in order to eliminate any depth cues the bottom of the box was painted gray on the outside. The stabilimeter was mounted on a brass pivot of adjustable height. The height of the units was set such that whenever a plastic box rested on any one of four microswitches, there was a resulting tilt of 1/8 of an inch from the horizontal.

The microswitches were mounted on the center of each side of each stabilimeter. Opposite switches engaged the same counter. When the stabilimeter tilted as a result of an animal moving, one of the switches was depressed and activated the counter. Photoelectric cells of the Hunter variety (Model #335S Series) were mounted on stands, two to a unit, and set at 90 degrees to one another. The light sources were mounted directly opposite to the cells and were shielded from S's vision by an infra-red filter. Each cell engaged an independent counter. These were activated whenever an animal broke the light beam. All counters were resettable and were placed at a good distance outside the colony experimental room.

The top portion might best be described as a "collar" for extension of the walls of the plastic boxes. They were made of 3/8" plywood and fitted over the plastic boxes overhanging by a $\frac{1}{4}$" and leaving a gap to allow for tilt. The "collar" was hung from the ceiling of the large housing unit on short pieces of 2 x 2. As can be seen in Fig. 2, the front wall of the "collar" was attached by hinges and provided a door for access to the stabilimeters. The walls were painted flat white on the inside.

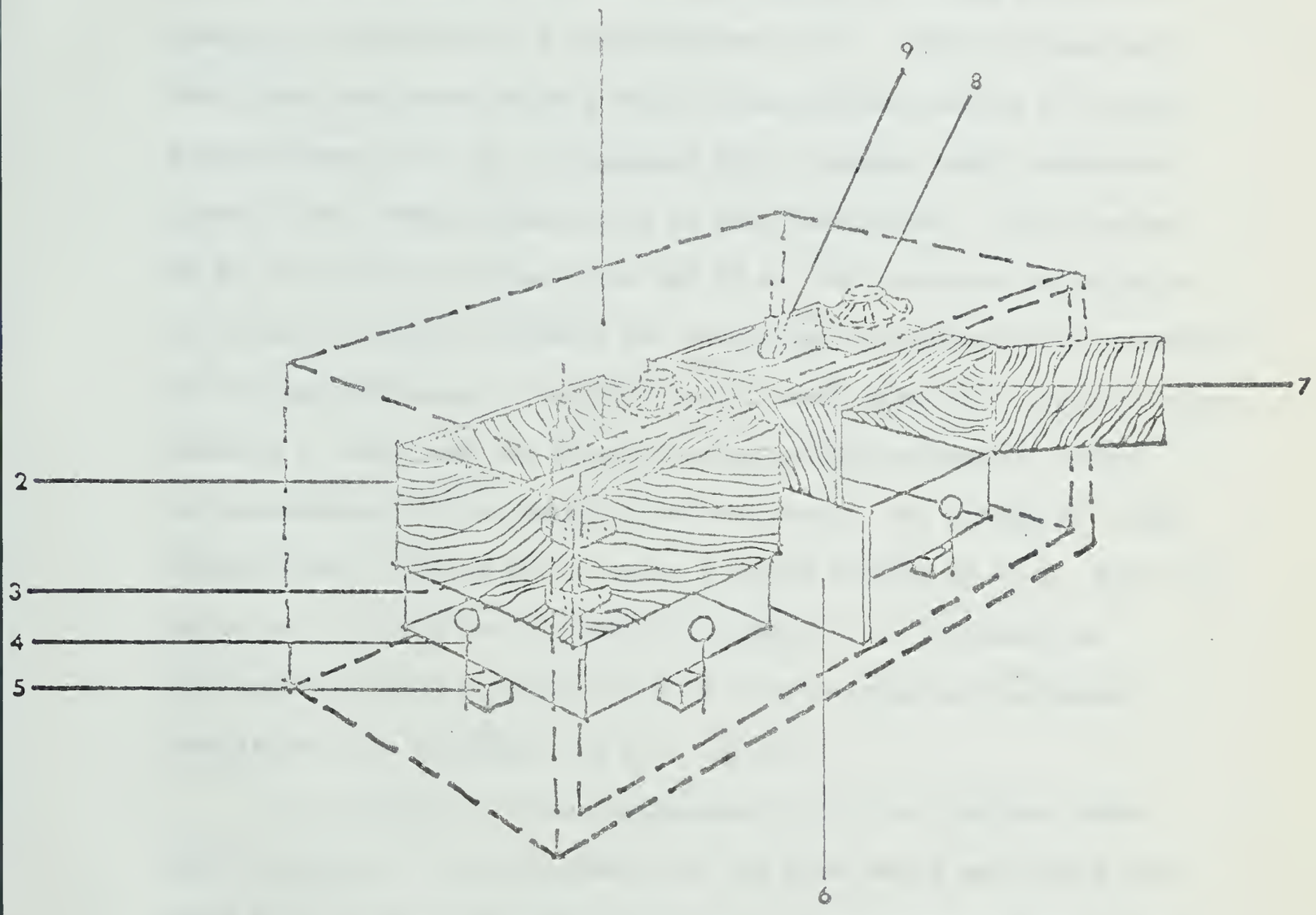

FIG. 2

Full view of one of the experimental units.

1. 3/4" plywood housing unit
2. 3/8" plywood extension of the stabilimetre
3. stabilimetre
4. photo-electric cell
5. mounting for the micro-switch
6. piece of white cardboard
7. white cardboard shield for light
8. loud speaker
9. light bulb

Each stabilimeter had its own four inch permanent magnet loudspeaker and an incandescent light socket mounted overhead for light and sound stimulation. The sound level was controlled by a resistance box outside the housing unit and was changed by throwing a switch to change the resistance to a predetermined level. "Standard" auditory conditions were provided by a white noise generator giving a constant auditory level of 76 db. as measured with a General Radio Audiometer placed in the centre of the floor of the stabilimeter. The value was 86 db. for increased stimulation and 66 db. for decreased stimulation. The level of light stimulation was controlled by variacs which controlled the voltage delivered to the 60 W bulb in each apparatus. The luminance produced by this lamp was measured using an SEI photometre, taking the measurement at the centre of the rear wall. The "standard" light intensity was 1.75 log Ft.L., using a variac setting of 84 V. With the variac set at 114 V for increased stimulation, the luminance was 2.40 log Ft.L; with a setting of 60 V on the variac for decreased stimulation, the luminance was 1.35 log Ft.L.

As a result of using incandescent bulbs for lighting, there was an increase in the temperature of the boxes while each group was being run. The change was approximately 2.5 degrees centigrade (from 26 degrees centigrade to 28.5 degrees centigrade) over the 20 minutes, under the highest illumination level. In order to minimize temperature fluctuations, a warming up period of 20 minutes under standard illumination was used in each box prior to putting the first group in for running each day. At the end of each experimental run, the experimental

units were left open to allow for cooling. It was found that these ten minutes were sufficient to create approximately the same starting conditions for all animals. Appendix 1 shows the changes in temperature over a typical day's trials.

Procedure

The animals were randomly assigned to treatments and run six at a time. For the first three days they were under ad lib feeding conditions. For the first ten minutes of running time, light and sound stimulation were approximately the same as those in the colony room. At that point, readings were taken from the counters, (automatically stopped by a timer) for each animal for both measuring devices. This measure was taken as an indicant of the basal activity level prior to stimulus change.

After taking the readings, the intensity of both light and sound were changed. In one housing unit this consisted of increasing the level of both light and sound; in another, decreasing the level; and in the remaining unit maintaining the level at the pre-change degree. The counters were again activated for a ten minute period, and the total recorded at the end of that time. On the first three days this served as a measure of their activity level as a result of light and sound stimulation changes alone. The animals were then returned to their home cages and ten minutes later another group of six were started.

Following day three, one-half of the animals was placed on twenty-three hour food deprivation schedule, being fed for one hour

following removal from the apparatus. At the same time, the other half of the animals was placed on an one hour food deprivation schedule, having their food removed one hour before running. The running procedure on days four through seven was identical to that used on the first three days. Ten minutes after returning to their home cage, the animals were fed, the twenty-three hour group having food removed an hour later. Ss were run at the same time each day.

Each variable was equally represented in each experimental unit.

Design

Basically the experiment used a four factor split-plot design. The factors and their respective levels are given below:

A. External Stimulation: a-1 light and sound increase;
a-2 no change in levels;
a-3 light and sound level decrease;

B. Deprivation (coming into effect following the third day running): b-1 one hour deprivation;
b-2 twenty-three hours deprivation;

C. Time Interval: c-1 ten minutes with the light and sound level matching those of the environment;
c-2 ten minutes immediately following c-1 in which the stimulus changes indicated in A took place;

D. Repeated Measures over seven days.

There were independent groups for Ss for each level of factors A and B.

ANALYSIS

Both variance and covariance analyses were carried out on the data in both measures, and a square root transformation was applied to the raw data prior to the analysis. In order to partial out the large initial difference between the experimental groups, the covariance analysis was the most appropriate analysis to be used. The predictor variable here was the transformed score in the first ten minutes of day one. This was the only score which was unaffected by the experimental variables and hence the only score meeting the criterion of the predictor variable.

The split-plot analysis of variance was run on the square root of the raw data socres for days four through seven. The first three days were omitted because the deprivation variable was not used until day four.

RESULTS

Since the covariance analysis is the most appropriate analysis for this study, only those results will be considered in the discussion. For reference purposes, however, the analysis of variance has been included in the Appendix.

Photo-cells

Table 1 shows the results of the analysis of covariance for the photo-cells. The time interval (designated by "C") provided the only variable with a significant main affect.

The means were significantly higher during the first ten minute interval ($\bar{X}$ = 2.583) than during the second ten minute interval ($\bar{X}$ = 1.296). There were no significant interaction effects.

Micro-Switches

The results of the analysis of the micro-switch data are shown in Tables 2 through 4.

A (Stimulation Level) and C (Time Interval) provided the only significant main effects.

For A, Table 5 shows the means of the Duncan's New Multiple Range Tests (Edwards, 1960). There were no significant differences brought out by this test. According to Peritz (1965), however, the significance of this factor implies that the three means can be

TABLE 1

RESULTS OF THE ANALYSIS OF COVARIENCE
FOR DAYS 4-7 ON THE TRANSFORMED DATA
FOR PHOTOCELLS.

Source	d.f.	2(ssy-ssx)/ssx	Mean Square	F.
A	2	19.51	9.76	1.37
B	1	11.86	11.86	1.67
AxB	2	27.16	13.58	1.91
Error(subject)	65	462.01	7.11	
C	1	238.31	238.31	77.05**
AxC	2	7.15	3.57	1.16
BxC	1	.00	.00	<1.00
AxBxC	2	13.05	6.53	2.11
Error(CxSubjects)	65	201.05	3.09	
D	3	2.22	0.74	<1.00
AxD	6	17.51	2.91	2.01
BxD	3	2.54	0.85	<1.00
AxBxD	6	12.01	2.00	1.38
Error(DxSubjects)	197	286.24	1.45	
CxD	3	4.43	1.48	1.17
AxCxD	6	12.30	2.05	1.62
BxCxD	3	1.07	0.36	<1.00
AxBxCxD	6	5.77	0.96	<1.00
Error(CxDxSubjects)	197	248.89	1.26	

** - P<.01

TABLE 2

RESULTS OF THE ANALYSIS OF COVARIANCE
FOR DAYS 4-7 ON THE TRANSFORMED DATA
FOR MICRO-SWITCHES

SOURCE	d.f.	2(ssy-ssx)/ssx	Mean Square	F
A	2	227.63	113.8]	3.32*
B	1	13.12	13.12	<1.00
AxB	2	8.75	4.37	<1.00
Error(subjects)	65	2227.06	34.26	
C	1	805.77	805.77	69.47**
AxC	2	80.34	40.17	3.46*
BxC	1	0.11	0.11	<1.00
AxBxC	2	0.72	0.36	<1.00
Error(CxSubjects)	65	753.87	11.60	
D	3	28.48	9.49	1.56
AxD	6	39.26	6.54	1.08
BxD	3	2.57	0.86	<1.00
AxBxD	6	35.47	5.91	<1.00
Error(DxSubjects)	197	1198.65	6.08	
CxD	3	4.32	1.44	<1.00
AxCxD	6	30.92	5.15	1.49
BxCxD	3	8.28	2.76	<1.00
AxBxCxD	6	20.72	3.45	<1.00
Error (CxDxSubjects)	197	682.50	3.46	

* $P < .05$
** $P < .01$

TABLE 3

ACTIVITY MEANS FOR THE STIMULATION GROUPS ON THE TRANSFORMED DATA FOR DAYS 4-7 USING MICRO-SWITCHES: A-1--STIMULUS INCREASE GROUP; A-2--NO STIMULUS CHANGE: A-3--STIMULUS DECREASE GROUP.

M.S.	A-1	A-2	A-3
Mean.	4.865	4.278	5.806

TABLE 4

ACTIVITY MEANS FOR THE STIMULATION GROUP AND TIME INTERVAL INTERACTION IN THE TRANSFORMED DATA FOR DAYS 4-7 USING MICRO-SWITCHES: A-1--STIMULUS INCREASE GROUP: A-2--NO STIMULUS CHANGE; A-3--STIMULUS DECREASE GROUP:

M.S.	C-1	C-2
A-1	5.836	3.812
A-2	5.161	3.490
A-3	7.501	4.099

C-1-- 1st. ten minute interval; C-2--2nd ten minute interval.

divided into two groups; those which fall above the grand mean and those which fall below it. The significant F then is the result of the A3 group being significantly different from A2 and/or A1.

As for C, mean activity during the first ten minutes was higher ($\bar{X}$ = 6.166) than that during the second ten minute interval ($\bar{X}$ = 3.801).

A X C provided the only significant interaction with the microswitches. This interaction is shown in Table 4. Relative to the control group, A2, the stimulus decrease group showed the greatest reduction in activity level following stimulus change.

DISCUSSION

Two predictions were made in this study: (a) that there would be an increase in activity resulting from food deprivation alone; and (b) if there were increases in activity resulting from food deprivation, then a change in the external stimulus, regardless of the direction of that change, would increase the activity level over and above that produced by the food deprivation. An incidental observation was also being made on the type of activity being measured by the two different devices. Since the results obtained from the two measuring devices are not the same, and since it is likely they are measuring two different types of activity (Strong, 1957) the results of these two devices will be discussed separately.

Photo-cells

Since the photo-cells are activated only with a sizeable object breaking the beam, it would seem reasonable to assume that a count would be registered only by an animal passing through the beam and out again. It would appear, therefore, that the photo-cells would be most sensitive to gross locomotor activity. This interpretation is consistent with Strong's conclusions (1957).

The first hypothesis in this study was not confirmed. Nor was the second hypothesis upheld. This is in direct opposition to Campbell & Sheffields' (1959) and Hall's (1956) results.

There is, however, a possible explanation for the lack of any effect here. Examining the means for the two deprivation groups on days two and three (Appendix 3) reveals that there was a large difference between the two deprivation groups prior to the introduction of food deprivation. This difference was statistically significant ($F = 3.98$, $df = 66$, $p < .05$). Unfortunately, the groups which was later subjected to food deprivation had the smaller mean. The difference between the two groups tended to diminish after the introduction of food deprivation (Appendix 3), which suggests that food deprivation was producing an increase in activity. However, the analysis of covariance was apparently not sufficient to compensate for the initial differences between the groups.

The significant time interval difference would possibly be the result of a novelty effect; that is, being taken from the home cage and placed in the experimental apparatus each day constituted the "novel" situation, albeit a decreasingly novel one over days. Exploration of the apparatus itself probably followed immediately upon placement in the apparatus and after re-familiarization with the particular apparatus, the animal's activity stabilized at a lower rate. Unfortunately, a break-down of the twenty minute interval into smaller than ten minute units was not attempted and thus the activity curve over the twenty minutes cannot be provided to support this hypothesis. Experimental evidence to support this suggestion can be found in the studies of Berlyne (1955) and Montgomery (1953). In their studies the authors measured the amount of exploratory behavior in rats exposed to a novelty situation over a longer period of time. They found the amount of exploration decreased with increased exposure to the novel environment.

Micro-Switches

The micro-switches were designed to respond to any movement which caused the stabilimeters to tilt or vibrate. Thus it seems reasonable to assume that movements such as scratching, sniffing and rearing were being recorded by the micro-switches. It seems likely, therefore, that the micro-switches were sensitive to both locomotor and non-locomotor activity. This is consistent with Strong's findings (1957).

Let the A X C interaction be examined first. Table 4 shows that the main reason for the significance of the interaction is the activity change of the A3 group and the high score of this group during the first ten minutes. One explanation for these data is that during the first ten minutes the stimulus decrease group was anticipating the change in stimulation. Since a number of studies have demonstrated that stimulus change can be positively reinforcing for rats (Lockard, 1963), it is possible that the stimulus change was reinforcing whatever kinds

of locomotor or non-locomotor responses the animal was emitting just prior to the stimulus change. This would result in greater activity during the first ten minutes than for the group receiving no stimulus change.

Further evidence for this hypothesis is found in the A X C X D interaction. While not significant, these means, shown in Appendix 2 show that the stimulus increase group tended to increase its activity over days two through seven. The stimulus increase group showed little change while the control group showed a decrease in activity. These data are consistent with the hypothesis.

Although both the stimulus decrease and stimulus increase groups exceeded the control (no change) group during the first ten minutes, the mean for the stimulus increase group is only slightly greater than the control mean (Table 3). If the above reinforcement hypothesis is accepted it is necessary to explain why the stimulus increase group failed to increase its activity to the same degree as the stimulus decrease group. A possible explanation for this effect lies in the different temperatures produced in the apparatus following stimulus change (Appendix 1). The stimulus increase group was subjected to the highest temperatures during the second ten minutes. Studies on temperature and activity indicate that as temperature increases, activity decreases (Browman, 1943; Stevenson and Rixon, 1957). Browman showed that the gross locomotor activity of rate is lower at 84 - 87^{o} F than at room temperature (70^{o} F). The temperatures attained in the present study were of the same magnitude, 85^{o} F being the highest recorded temperature (with stimulus increase) and 82.6^{o} F being the lowest recorded temperature (following stimulus decrease). It is suggested, therefore, that the stimulus increase group showed a lower level of activity during the first ten minutes as a result of the temperature increase during the second ten minutes. Possibly the increase in temperature was negatively reinforcing which would tend to counteract the positively reinforcing effect of the stimulus change. It must be noted, however, that these hypotheses are speculative and any firm conclusions must await further experimental evidence.

It is apparent that the significant A (stimulus change) main effect is due primarily to the activity of the stimulus decrease group during the first ten minutes. Consequently, this effect may be explained in terms of exploratory behavior and stimulus novelty. As the novelty of the situation wears off, exploratory behavior would tend to decrease (Berlyne, 1955; Montgomery, 1953). This hypothesis is consistent with the observation that the group receiving no stimulus change had the lowest level of activity during the second ten minutes (Table 4). Presumably the stimulus increase and stimulus decrease groups were exhibiting more exploratory behavior due to the greater stimulus novelty induced by the stimulus change. However, since no direct evidence of exploratory behavior per se exists, conclusions here must be tentative.

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APPENDIX

APPENDIX I

SHOWING THE TEMPERATURES INSIDE THE APPARATUS AT THE START OF THE INDICATED INTERVALS. THIS IS TYPICAL FOR ONE DAY'S RUN WITH FOUR GROUPS OF ANIMALS

Interval	Centigrade Degrees	Fahrenheit Degrees
Rest (10 minutes)	26	78.8
"Standard" Stimulation	27	80.6
Increased Stimulation	28.1	82.6
Rest (10 minutes)	27.5	81.5
"Standard" Stimulation	28.1	82.6
"Standard" Stimulation	28.8	83.8
Rest (10 minutes)	27.9	82.2
"Standard" Stimulation	28.5	83.3
Decreased Stimulation	28.5	83.3
Rest (10 minutes)	27.9	82.2
"Standard" Stimulation	28.3	82.9
Increased Stimulation	29.4	85.0
Rest (10 minutes)	28.5	83.3

APPENDIX.

TABLE SHOWING THE AxCxD INTERACTION UNDER C_1: A1, STIMULUS INCREASE; A_2 NO CHANGE; A_3 STIMULUS DECREASE: C1, FIRST TEN MINUTE INTERVAL. D2...D7: DAYS 2 THROUGH 7.

	D_2	D_3	D_4	D_5	D_6	D_7
A_1	5.97	5.07	6.76	5.96	5.46	5.72
A_2	5.79	6.10	5.59	4.96	4.86	4.59
A3	6.73	6.31	7.27	7.95	7.61	7.25

TABLE SHOWING THE AxCxD INTERACTION UNDER C_2: A1, STIMULUS INCREASE; A_2 NO CHANGE; A_3 STIMULUS DECREASE: C2, SECOND TEN MINUTE INTERVAL: D2...D7: DAYS 2 THROUGH 7.

	D_2	D_3	D_4	D_5	D_6	D_7
A_1	3.00	2.86	3.85	4.64	3.99	3.33
A_2	3.36	4.09	4.04	3.43	3.17	2.69
A_3	4.21	3.98	3.78	4.22	3.73	4.75

APPENDIX 3

TABLE SHOWING THE BxD INTERACTION MEANS FOR THE TRANSFORMED DATA FOR PHOTO-CELLS: B-1-- 1 HOUR DEPRIVATION: B-2--23 HOUR DEPRIVATION: $D_2 \ldots 7$-- DAYS TWO THROUGH SEVEN.

	D_2	D_3	D_4	D_5	D_6	D_7
B_1	2.49	2.08	2.10	2.20	2.02	2.02
B_2	1.88	1.80	1.96	1.70	1.80	1.71

APPENDIX 4

RESULTS OF THE SPLIT-PLOT ANALYSIS OF THE TRANSFORMED ACTIVITY SCORE FOR DAYS 4-7 USING PHOTOCELLS

No.:	SOURCE:	D.F.	SUMS OF SQUARES	M.S.	F	TEST SRC
1	A	2	25.7	12.90	1.49	16
2	B	1	17.26	17.26	1.99	16
3	AB	2	16.04	8.02	<1.00	16
4	C	1	238.32	238.32	78.24**	17
5	AC	2	7.14	3.57	1.17	17
6	BC	1	.00	.00	<1.00	17
7	ABC	2	13.05	6.53	2.14	17
8	D	3	2.23	0.74	1.00	18
9	AD	6	17.50	2.92	2.02	18
10	BD	3	2.54	0.85	<1.00	18
11	ABD	6	12.02	2.00	1.39	18
12	CD	3	4.43	1.48	1.17	19
13	ACD	6	12.31	2.05	1.63	19
14	BCD	3	1.07	0.36	0.29	19
15	ABCD	6	5.76	0.96	0.76	19
16	F	66	571.30	8.66	0.76	19
17	CF	66	201.05	3.05		
18	DF	198	286.24	1.45		
19	CDF	198	248.89	1.26		
33	ERROR	0				
	TOTAL	575	1682.93			

* $P < .05$
** $P < .01$

APPENDIX 5

RESULTS OF THE SPLIT-PLOT ANALYSIS OF THE TRANSFORMED ACTIVITY SCORES FOR DAYS 4-7 USING MICRO-SWITCHES.

NO.:	SOURCE:	D.F.	SUMS OF SQUARES:	M.S.	F	TEST SRC:
1	A	2	201.95	100.97	2.50	16
2	B	1	2.73	2.73	<1.00	16
3	AB	2	18.56	9.28	<1.00	16
4	C	1	805.81	805.81	70.55	17
5	AC	2	80.30	40.15	3.52	17
6	BC	1	.07	.07	<1.00	17
7	ABC	2	0.77	0.38	<1.00	17
8	D	3	28.52	9.51	1.57	18
9	AD	6	39.22	6.54	1.08	18
10	BD	3	2.54	0.84	<1.00	18
11	ABD	6	35.51	5.92	<1.00	18
12	CD	3	4.29	1.43	<1.00	19
13	ACD	6	30.97	5.16	1.50	19
14	BCD	3	8.32	2.77	<1.00	19
15	ABCC	6	20.68	3.45	<1.00	19
16	F	66	2666.65	40.40		
17	CF	66	753.87	11.42		
18	DF	198	1198.65	6.05		
19	CDF	198	682.49	3.45		
33	ERROR	0				
	TOTAL	575	6581.89			

* $P < .05$
** $P < .01$